A.D. 1872, 20th MARCH. N° 849.

SPECIFICATION

OF

HENRY YOUNG DARRACOTT SCOTT.

TREATING SEWAGE WATER.

LONDON:
PRINTED BY GEORGE E. EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY:
PUBLISHED AT THE GREAT SEAL PATENT OFFICE,
25, SOUTHAMPTON BUILDINGS, HOLBORN.
1872.

A.D. 1872, 20*th* MARCH. N° 849.

Treating Sewage Water.

LETTERS PATENT to Henry Young Darracott Scott, of Ealing, in the County of Middlesex, Major-General, C.B., for the Invention of "IMPROVEMENTS IN THE TREATMENT OF SEWAGE WATER."

Sealed the 22nd May 1872, and dated the 20th March 1872.

PROVISIONAL SPECIFICATION left by the said Henry Young Darracott Scott at the Office of the Commissioners of Patents, with his Petition, on the 20th March 1872.

I, HENRY YOUNG DARRACOTT SCOTT, of Ealing, in the County of Middlesex, Major-General, C.B., do hereby declare the nature of the said Invention for "IMPROVEMENTS IN THE TREATMENT OF SEWAGE WATER," to be as follows:—

The chief object of this Invention is the extraction from sewage water of the ammonia (which it contains) in a form in which it can be made readily available as a marketable article. The process has the collateral advantages of obtaining phosphates of alkaline earths in a condition very suitable for a manure, and of effecting a further and more complete

purification of sewage water than can be brought about by a single precipitation process.

In carrying out my Invention I commence by removing from the sewage the grosser fœcal matters and impurities, and for this purpose I prefer the method of precipitation by lime. I then agitate with the effluent water from such precipitated matters hydrated phosphate of magnesia, which when allowed to subside will carry down with it, in chemical combination the ammonia contained in the sewage water, and with which ammonia the phosphate comes into contact.

When excess of lime has been used in the preliminary precipitation of the grosser foecal matters, phosphoric acid in some soluble combination, such as in the form of a phosphate, may be employed to separate the free lime from the liquid before the phosphate of magnesia is added, or the other and soluble phosphate may be added simultaneously with the introduction of the insoluble phosphate of magnesia.

When the insoluble compounds (formed by the action of their phosphates) have settled, the supernatant liquid is to be drawn off, and these solid compounds are collected, dried, and exposed to heat in order to expel the ammonia which has been absorbed, and which may after expulsion be collected by well known chemical methods. Or the compounds may be carefully dried and sent into the market as manure.

As hydrated phosphate of magnesia is not perfectly insoluble some of this substance will be carried away in the effluent water and be lost, unless the water be applied to irrigation purposes; I therefore sometimes add to it a sufficient quantity of milk of lime to precipitate the phosphoric acid dissolved in the water.

When I can obtain the calcareous substances containing both carbonic acid and phosphoric acid in considerable proportions I calcine such substances, and having dissolved out the lime, I employ the lime for the preliminary precipitation of the grosser foecal matters of the sewage, and I use the phosphate of lime (which remains undissolved in the water) for the preparation of the phosphate of magnesia required for the collection of the ammonia.

Scott's Improvements in Treating Sewage Water.

SPECIFICATION in pursuance of the conditions of the Letters Patent, filed by the said Henry Young Darracott Scott in the Great Seal Patent Office on the 20th September 1872.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, HENRY YOUNG DARRACOTT SCOTT, of Ealing, in the County of Middlesex, Major-General, C.B., send greeting.

WHEREAS Her most Excellent Majesty Queen Victoria, by Her Letters Patent, bearing date the Twentieth day of March, in the year of our Lord One thousand eight hundred and seventy-two, in the thirty-fifth year of Her reign, did, for Herself, Her heirs and successors give and grant unto me, the said Henry Young Darracott Scott, Her special licence that I, the said Henry Young Darracott Scott, my executors, administrators, and assigns, or such others as I, the said Henry Young Darracott Scott, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for "IMPROVEMENTS IN THE TREATMENT OF SEWAGE WATER," upon the condition (amongst others) that I, the said Henry Young Darracott Scott, my executors or administrators, by an instrument in writing under my, or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

NOW KNOW YE, that I, the said Henry Young Darracott Scott, do hereby declare the nature of my said Invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement (that is to say):—

The chief object of this Invention is the extraction of ammonia from sewage, in which term I include all such waste and polluted waters of towns and factories as require purification before being cast into rivers and streams used for domestic purposes.

The improved method whereby this is effected has the collateral advantage of yielding phosphates of alkaline earths in a condition very suitable for agricultural purposes. It also effects a further and more complete purification of sewage than can be brought about by a single precipitation.

In carrying out my Invention I commence by removing from the liquid to be treated all the grosser fœcal matters and suspended impurities, and for this purpose I prefer the method of precipitation by lime.

I also prefer to make use of dolomitic lime in lieu of pure or ordinary lime. Out of the dolomitic lime I first dissolve the lime by means of clarified sewage water, and I then mix the solution of lime so obtained with the sewage to be precipitated. I employ the magnesia which remains undissolved in the liquid for the preparation of the phosphate of magnesia, which I subsequently use for the extraction of the ammonia from the polluted or sewage waters.

I sometimes employ for the preliminary precipitation of sewage calcined calcareous phosphatic minerals, out of which I dissolve the lime in the same manner as I practice with the dolomitic lime for the removal of its grosser fœcal matters, whilst the undissolved phosphates are made available for the supply of the phosphoric acid in the preparation of the said phosphate of magnesia.

With the view of facilitating the separation of the lime from the phosphates of such minerals I sometimes intimately incorporate with them (previous to their calcination) a sufficiency of lime to produce slaking in the calcined compound.

In any case, whether ordinary lime be employed or whether magnesian lime or phosphatic lime be used as the source of supply of the lime with which the sewage is clarified, the precipitate so obtained is allowed to deposit in a tank or tanks, which I will call No. 1. This deposit may be calcined and converted into cement or agricultural lime according to methods now in use, or it may be mixed with town ashes and employed as manure, or it may be converted into charcoal and be used for the filtration of the sewage or for other purposes. In cases in which straining or subsidence are employed for the removal of the grosser fœcal matters it is still advantageous to use some process of precipitation before applying the phosphate of magnesia, with which I

extract the ammonia. With waste waters comparatively free from suspended matter the process of removing the ammonia may be applied at once.

The chief object of the precipitation, so far as my present object is concerned, is to avoid burthening valuable products to be obtained with the comparatively worthless substances which would otherwise be thrown down with them.

The effluent from tank No. 1 will probably carry away with it in solution notable quantities of lime or lime salts which it is very desirable but not essential to remove in tank No. 2, by the addition to it of superphosphate of magnesia, superphosphate of lime, phosphate of soda, or phospheric acid, which will precipitate it as insoluble phosphate. These substances may be used singly or in conjunction, but I prefer to employ superphosphate of magnesia. The deposit thus formed may be collected and dried for manure, or it may be subject to distillation, and be converted into charcoal which will be useful for many purposes. The carbon is of course supplied by the organic matter which the precipitate carries down with it in settling. Appreciable quantities of ammonia will also be found in this deposit. The lime carried away in solution from tank No. 1 may be partially removed also by filtration through charcoal, burnt ballast, or other suitable substance.

The effluent from tank No. 2 thus freed from lime passes on to tank No. 3, where, and in tank No. 3[a], the operation for the extraction of the ammonia is to be carried out by extracting it with phosphate of magnesia, with which it enters into combination readily. This salt is well known to be very insoluble in weak ammoniacal solutions, and the idea of taking advantage of this property for the extraction of ammonia from them is not new. Various attempts have been made to effect the object by bringing together in the ammoniacal liquid to be treated phosphoric acid and magnesia in the form of soluble salts of those substances, in the hope that the ammoniacal phosphate of magnesia would be precipitated; but all such attempts have proved failures for reasons well known to chemists. When forming this salt for purposes of analysis, chemists invariably allow the liquid to stand for several hours after concentrating the solution operated upon by evaporation, as the salt, notwithstanding its insolubility in weak ammoniacal solutions, has the peculiarity of precipitating very slowly. The conditions of concentration and long standing are of course impracticable with sewage and other polluted water

in consequence of the large volumes that will have to be dealt with, and their unceasing flow in most cases from the sewers, and the processes alluded to have not extracted a sufficient quantity of ammonia to justify the expense of the treatment.

The mode of operation which I adopt is this:—I take phosphate of magnesia in a fine state of division (by preference in the form of a paste and prepared in any convenient manner) and agitate the ammoniacal liquid to be treated with it in tank No. 3. The result is that the phosphate of magnesia removes from the liquid the ammonia with which it is brought in contact.

The conditions necessary to ensure success are (first) that the phosphate of magnesia shall be in the hydrated and not the anhydrous condition, as this salt, after ignition, shews so little tendency to unite with the ammonia as to be practically inefficient; second, that the phosphate of magnesia shall be present in sufficient quantity and in such excess as to render the whole liquid treated what may be termed milky, for if introduced in sufficient quantity only to combine chemically with the ammonia present in the charge under treatment, the amount of ammonia extracted will, with any feasible amount of stirring or opportunity for subsidence, be insufficient to repay the cost of the process. This will be readily understood, for although substances capable of forming new chemical compounds will at once unite when mixed together in a state of solution in their proper combining proportions, this result is hardly to be expected when one of the substances is in a solid form, and in order to secure anything like an efficient removal of the ammonia from its dilute solutions it is necessary that the liquid should be crowded (so to speak) with active particles of the solid substance. Even when such a superabundance of the phosphate salt is present the whole of the ammonia will not be extracted in one, nor indeed will every trace of it be removed by several operations similar to that above described, and therefore where possible it is better to employ a second, or even a third phosphate tank, which I may call No. 3^a and 3^b, wherein the effluent from No. 3, after the solid particles of ammoniacal phosphate of magnesia and the unused (if I may so express myself) phosphate of magnesia have subsided, may be agitated with a fresh charge of the magnesian phosphate. After these tanks have been refilled and emptied several times, the waste of the magnesian phosphate being made up by fresh additions of that salt introduced from time to time, the deposit is to be collected,

and may then be used as a manure, either alone or mixed with the deposit from the other tanks, or the ammonia may be distilled from it and collected in the ordinary modes, and the anhydrous phosphate remaining may be again converted into hydrate by well-known methods, and used for extracting the ammonia from fresh charges of the liquid.

The effluent from the phosphate of magnesia tanks should be subjected to a further treatment, for were the process to stop here there would be a certain waste of phosphate of magnesia with each charging of the tanks, as this salt is sparingly soluble in water. To arrest such loss I treat the effluent liquid from Nos. 3, or 3^a, 3^b, with milk of lime in tank No. 4. The lime may with advantage be prepared from dolomite, as the precipitate of phosphate of lime will then be mixed with magnesia, which will be useful for the preparation of the phosphates of magnesia required in the foregoing processes. The lime used for this precipitation may also be prepared from minerals containing carbonate of lime and phosphates intermingled, or of such lime combined with dolomitic lime as I am enabled by means of the deposit thus produced to economize in the production of the phosphate of magnesia required for the above processes. I may use also sulphates or chlorides of iron and aluminium for the removal of the phosphoric acid from the liquid, both of the bases of these salts forming insoluble substances with it. Other salts might be similarly used, but no corresponding advantage for the increased expense would be gained.

The effluent from tank No. 4 will, after these operations, be found to be purified to a considerable extent, as a certain proportion of organic matter will be carried down with each precipitation. It may be now filtered through charcoal prepared from the deposit obtained in tank No. 1 (which will be found to possess deodorizing and decolorizing properties in a high degree) by a process of carbonization, the tarry matters and ammonia distilled off being collected and utilized; or the effluent may be filtered through gravel or soil, or employed in irrigation. For efficient filtration purposes a much smaller mass of filtering matter will suffice than before these precipitations.

Although I consider the above to be the best mode of proceedure I do not confine myself to it, for I may produce similar results by filtering the clarified sewage water through the crystallised phosphate of mag-

nesia, or through a mixture of this salt and animal or other charcoal, or I may use a filter of animal or other heavy charcoal, as the bottoms of tanks No. 3, 3ª, 3ᵇ, and by keeping the phosphate of magnesia in suspension in the liquid above allow the liquid to filter through the bottom instead of being drawn off at the top.

Again, in lieu of stirring the phosphate of magnesia in with the liquid, I may keep it in a state of suspension in the liquid, by pumping air into the tanks, and I may also keep it in suspension by allowing the clarified liquid to rise from the bottom upwards and flow over the top. By properly regulating the depth of the tanks, the flow of liquid, and the amount of phosphate of magnesia, I may even render the process continuous; but I have found this and the other processes above mentioned less easy to carry out than the first described process where ordinary subsidence is employed for the separation of the liquid from the deposits obtained.

In cases in which there is difficulty in arranging for so great a number of tanks I may combine the first and second precipitations by adding, first, the lime to the sewage as it flows through the sewer, and then, when this has had time to act, by adding also in the trough which conveys the sewage to the first settling tank the phosphoric acid or soluable phosphate to precipitate the lime still remaining in solution, or I may introduce the soluble phosphate into the conduit which leads to the phosphate of magnesia tank, and allow the phosphate of lime to settle in it with the magnesian salts; or again, I may dispense altogether with the operations to be performed in No. 4, but at the cost of losing some of the phosphate of magnesia.

Again, in lieu of introducing into tanks 3, 3ª, &c., phosphate of magnesia as such, I may make use in the tanks themselves of substances which will by combination form this salt; for instance, I may from time to time put into tank No. 2, or into the channel that leads to it, an excess of superphosphate, such as superphosphate of magnesia, and allow the liquid so charged to pass into tank 3, 3ª, &c., to be there agitated with a large quantity of magnesia to be used by preference in the hydrated state. The result of this treatment will be the production of phosphate of magnesia in a condition to combine with the ammonia of the liquid, either when the phosphate is in process of formation, or subsequently to its formation, on coming into contact with it.

There are other means also by which the special object here in view may be accomplished, such object being the procuring that the ammoniacal liquid to be dealt with shall for reasons already given be treated with a very large proportion of phosphate of magnesia as compared with the amount of ammonia in the volume of liquid under operation at any one time. Such other means however of introducing the phosphate magnesia do not yield as satisfactory results as the direct introduction of this salt, as above described.

Having now described my Invention of improvements in the treatment of sewage water, and having explained the means whereby I carry the same into effect, I wish it to be understood that I claim as the Invention secured to me by Letters Patent, as aforesaid, treating sewage from towns and manufacturing processes with hydrated phosphate of magnesia in the manner or manners herein set forth, for the purposes of purifying such waste liquid and obtaining the ammonia contained therein.

In witness whereof, I, the said Henry Young Darracott Scott, have hereunto set my hand and seal, the Nineteenth day of September, in the year of our Lord One thousand eight hundred and seventy-two.

HENRY Y. D. SCOTT. (L.S.)

LONDON:
Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1872.